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(continuous ambulatory peritoneal dialysis, CAPD)

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· CAPD 6 intact

parathyroid hormone( iPTH) 250pg/mL 가 33 ,

1 1 1.0 μg (IP , 11 ), 1 3

1.0 μg (SC , 11 ) 1 3 0.5- 1.0 μg (PO ,

11 ) 6 , iPTH, alkaline phosphatase, bone- specific

alkaline phosphatase, osteocalcin 1,25(OH) $\text{D}_3$

가

1) 11 (11/33, 33.3%) , IP 6 (6/11, 54.5%) , SC

4 (4/11, 36.4%) , PO 1 (1/11, 9.1%) .

11 5 , IP SC

PO ( $P < 0.05$ ).

2) 6 6 iPTH IP ,

SC PO  $47.8 \pm 22.8\%$  ,  $58.8 \pm 20.9\%$   $29.2 \pm 34.1\%$

( $P < 0.05$ ),

가 .

3) 6 alkaline phosphatase, bone- specific alkaline phosphatase

osteocalcin IP  $50.1 \pm 14.6\%$  ,  $33.5 \pm 11.6\%$  ,  $52.3 \pm 10.9\%$  ,

SC  $80.9 \pm 14.8\%$  ,  $67.4 \pm 20.8\%$  ,  $54.4 \pm 11.1\%$  , PO  $48.8 \pm 24.4\%$  ,  $36.6 \pm$

$23.5\%$  ,  $54.2 \pm 11.6\%$  ,

( $P < 0.05$ ), 가 .

4) Vit- D $\text{3}$ (pg/mL) (IP ;  $6.6 \pm 2.9$  , SC ;  $7.8 \pm 1.4$  , PO ;  $7.8 \pm$

$2.7$ ) 3 6 가 ( $P < 0.05$ ).

5) 6 22 (  $10.5\text{mg/dL}$ ) 7 (7/

22, 31.8%) , IP SC 2 (2/5, 40%) , 5 (5/7, 71.4%) PO (0/10,

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Tel : (02)361- 5419, Fax : (02)393- 6884

0% ) (  $P < 0.05$  ).

CAPD

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1), 2,3), 4,5), 6) 13), 14, 15), 16) 17) 가

7) CAPD 가

high turnover , adynamic bone disease low turnover CAPD

2,8). 50- 60% Vit- D3

가 1 . 6

가 9-12) CAPD iPTH 가 250pg/mL ( : 273.3- 1881.4 pg/mL) 33

Vit- D3 alfacalcidol[1 - 44.5 ± 12.3 ( : 18- 70 ) , 25- hydroxylation 가 19 , 가 14 42.8 ± 33.0 ( : 6- 108 ) , 15 , 1 , 10 , 7 2 , D

3.5 osteocalcin Vit- D3 immunoradiometric assay (Nichols Institute, San Juan Caspistrano, CA, USA) osteocalcin: 2.4- 11.7ng/mL, Vit- D3: 19.9- 67.0pg/mL . (2)

6 (Dual energy X-ray absorptiometry, DEXA) , DEXA Lunar DPX-L (Lunar Radiation, Madison, WI, USA) . (3)

6 (Acuson Corp, Mountainview, CA, USA)

6-8 (SC , n=11) 1.0 μg 1 3 , (PO , n=11) 1 18). 3 . 0.5 μg , 4 1 3 1.0 μg 8.5- 10.0mg/dL, 6.0mg/dL , 60 , paired stu- dent t-test , Chi-square test one way analysis of variance (ANOVA) , P 0.05 .

2) (1) , , iPTH alkaline phosphatase 2 4 , SC PO 798.2 ± 370.2, 720.9 ± 467.8 615.1 ± 502.8pg/mL , alkaline phosphatase(IU/L) bone-specific alkaline phosphatase(U/L) IP 216.9 ± 112.7, 104.9 ± 60.4; SC 213.2 ± 73.9, 93.4 ± 41.7; PO 271.2 ± 126.7, 70.7 ± 72.3 . Osteocalcin 가 , (Table 1).

( : 12- 75pg/mL). Bone-specific alkaline phosphatase ALKPHASE-B TM kit (Metra Biosystems, USA) ( ; : 15.0- 41.3U/L, : 11.6- 30.6U/L),

**Table 1. Comparison of Parameters among the 3 Groups Prior to Calcitriol Treatment**

|                                 | IP group(n=11) | SC group(n=11) | PO group(n=11) |
|---------------------------------|----------------|----------------|----------------|
| Ca(mg/dL)                       | 9.0 ± 0.7      | 8.9 ± 1.2      | 8.2 ± 0.6      |
| P(mg/dL)                        | 5.5 ± 1.0      | 5.4 ± 1.3      | 4.5 ± 1.3      |
| Alkaline phosphatase(ALP)(IU/L) | 216.9 ± 112.7  | 213.2 ± 73.9   | 272.1 ± 126.7  |
| Bone-specific ALP(U/L)          | 104.9 ± 60.4   | 93.4 ± 41.7    | 70.7 ± 72.3    |
| iPTH(pg/mL)                     | 798.2 ± 370.2  | 720.9 ± 467.8  | 615.1 ± 502.8  |
| Osteocalcin(ng/mL)              | 33.2 ± 8.3     | 31.9 ± 9.7     | 33.1 ± 8.9     |
| Vit- D3(pg/mL)                  | 7.8 ± 3.9      | 8.1 ± 1.9      | 7.6 ± 2.7      |
| Bone mineral density(g/cm2)     | 1.02 ± 0.15    | 0.97 ± 0.11    | 1.01 ± 0.08    |

Values are expressed as mean ± SD

**Table 2. Patients Status in the 3 Groups during Study Period**

|  | IP group(n=11) | SC group(n=11) | PO group(n=11) |
|--|----------------|----------------|----------------|
| No. of drop out patients(%)                  | 6(54.5)        | 4(36.4)        | 1(9.1)*#       |
| Causes of drop out                           |                |                |                |
| Peritonitis                                  | 5              | 0*             | 0*             |
| Transplantation                              | 0              | 1              | 0              |
| Persistent hypercalcemia & hyperphosphatemia | 1              | 2              | 0              |
| Noncompliance                                | 0              | 1              | 1              |
| No. of patients completed 6 months study(%)  | 5(45.5)        | 7(63.6)        | 10(90.9)*#     |

\*P<0.05, vs. IP group, #P<0.05, vs. SC group

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33 11  
(11/33, 33.3%), IP  
6 (6/11, 54.5%), SC 4 (4/11, 36.4%),  
PO 1 (1/11, 9.1%) PO  
IP SC (P<0.05). IP  
5 , 1  
, SC  
2 ,  
1  
1 4 .  
IP SC PO  
(P<0.05)(Table 2).

3.

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6 iPTH IP , SC  
PO 47.8 ± 22.8%, 58.8 ± 20.9%  
29.2 ± 34.1%  
(P<0.05),

**Fig. 1. Changes in iPH level(percentage of baseline value) in 3 groups. \*P<0.05 vs. baseline value.**

가 (Fig. 1). 6 alkaline phosphatase, bone-specific alkaline phosphatase osteocalcin  
IP 50.1 ± 14.6%, 33.5 ± 11.6%,  
52.3 ± 10.9%, SC 80.9 ± 14.8%, 67.4 ± 20.8%,  
54.4 ± 11.1%, PO 48.8 ± 24.4%, 36.6 ± 23.5%, 54.2 ± 11.6% ,

( $P < 0.05$ ), (Fig. 2). Vit-D<sub>3</sub>(pg/mL) (IP : 0.46 vs. 0.09; SC : 1.86 ± 2.36 vs. 1.22 ± 1.70; PO : 0.18 ± 0.16 vs. 0.04 ± 0.05 cm<sup>3</sup>) ( $P < 0.05$ ) (Table 4).

( $P < 0.05$ ) (Fig. 3). DEXA (g/cm<sup>2</sup>) (IP : 1.02 ± 0.15 vs. 1.09 ± 0.22, SC : 0.97 ± 0.11 vs. 0.97 ± 0.13, PO : 1.01 ± 0.08 vs. 1.09 ± 0.10), (Ca 10.5 mg/dL) (IP SC 2 (2/5, 40%)

4. alkaline phosphatase ( $r = 0.778$ ), bone-specific alkaline phosphatase ( $r = 0.806$ ) ( $P < 0.05$ ), DEXA ( $r = -0.503$ ,  $P < 0.05$ ). Osteocalcin bone-specific alkaline phosphatase ( $r = 0.391$ ,  $P < 0.05$ ), alkaline phosphatase (Fig. 2) ( $r = 0.220$ ,  $P > 0.05$ ) (Table 3).

**Fig. 2.** Comparison of alkaline phosphatase (ALP), bone-specific ALP (B-ALP) and osteocalcin among the 3 groups after 6-months calcitriol therapy (% of baseline values).

가 IP 1, SC 2, PO 2, 6

**Table 3.** Correlation Matrix among the Parameters Prior to Calcitriol Therapy

|                      | iPTH    | ALP    | B-ALP  | Osteocalcin |
|----------------------|---------|--------|--------|-------------|
| ALP                  | 0.778*  |        |        |             |
| B-ALP                | 0.806*  | 0.963* |        |             |
| Osteocalcin          | 0.185   | 0.220  | 0.391* |             |
| Bone mineral density | -0.503* | -0.343 | -0.295 | 0.125       |

\* $P < 0.05$

**Fig. 3.** Changes in serum Vit-D<sub>3</sub> level groups. \* $P < 0.05$  vs. baseline value.

**Table 4.** Changes of Parathyroid Gland Size by Ultrasonography in 3 Groups during Study Period

|   | IP group (n=5) | SC group (n=7) | PO group (n=10) |
|---|----------------|----------------|-----------------|
| Numbers of patients with enlarged parathyroid gland | 1              | 2              | 2               |
| Gland volume (cm <sup>3</sup> ) initial             | 0.46           | 1.86 ± 2.36    | 0.18 ± 0.16     |
| 6 month   | 0.09           | 1.22 ± 1.70    | 0.04 ± 0.05     |
| % decrease in gland volume                          | 80.43          | 63.1 ± 44.76   | 41.52 ± 78.80   |

Values are expressed as mean ± SD

**Table 5. Complications of Calcitriol Therapy in 3 Groups during Study Period**

|  | IP group<br>(n=5) | SC group<br>(n=7) | PO group<br>(n=10) |
|--|-------------------|-------------------|--------------------|
| Hypercalcemia(%)<br>( $>10.5\text{mg/dL}$ )    | 2/5(40)           | 5/7(71.4)         | 0/10(0)*           |
| Hyperphosphatemia<br>(%)( $>7.0\text{mg/dL}$ ) | 2/5(40)           | 1/7(14.3)         | 1/10(10)*#         |

\* $P<0.05$ , vs. SC group, # $P<0.05$ , vs. IP group

**Table 6. Comparison of Calcitriol and Phosphate Binders Given during 6 Months among the 3 Groups**

| Total dose/<br>patient      | IP group<br>(n=5) | SC group<br>(n=7) | PO group<br>(n=10) |
|-----------------------------|-------------------|-------------------|--------------------|
| Calcitriol( $\mu\text{g}$ ) | $155.6 \pm 11.8$  | $70.3 \pm 2.9^*$  | $63.5 \pm 2.5^*$   |
| $\text{CaCO}_3(\text{g})$   | $619.8 \pm 151.5$ | $540.0 \pm 95.3$  | $655.2 \pm 130.1$  |
| $\text{Al(OH)}_3(\text{g})$ | $22.7 \pm 36.5$   | $21.6 \pm 57.1$   | $44.4 \pm 96.4$    |

\* $P<0.05$ , vs. IP group

5 (5/7, 71.4%) 가  
PO (0/10, 0%)  
( $P<0.05$ ), ( $P>7.0\text{mg/dL}$ )  
IP 2 (2/5, 40%) SC (1/7,  
14.3%) PO (1/10, 10%)  
( $P<0.05$ )  
(Table 5).

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6  
 $155.6 \pm 11.8 \mu\text{g}$ , SC ( $70.3 \pm 2.9 \mu\text{g}$ ) PO  
( $63.5 \pm 2.5 \mu\text{g}$ ) ( $P<0.05$ ),  
가 (Table 6).

가 (Table 6).

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high turnover  
50- 60%  
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Vitamin- D  
Brickman 4)

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0.5- 1  $\mu$ g 1 3 가  
6 가  
Andress 27) 30% ,  
가 1  
11 1 (1/10, 10%)  
3 Scanziani 31)  
(osteoid) 가 . CAPD  
가  
28-30) 가  
CAPD  
가 CAPD  
Delmez 35) 11  
Salusky 14) CAPD 16 1 0.5- 2.0  $\mu$ g  
16 0.6  $\mu$ g  
53.9% ,  
가 가  
Scanziani 31) 47.7pg/dL  
19  
CAPD 0.75- 1.5  $\mu$ g . Vieth 36)  
1 3  
가 50% 가 3 63%  
, 6 , 12 18 20% , 57  
, 87% 100% ,  
10- 20% 가  
Martin 33) 3.5mEq/L  
5 CAPD 1 2 5  $\mu$ g 가  
4- 6  
가 60% , 4  
CAPD  
Bechtel 33) 15 CAPD 1 2 . Rolla 37) 7 CAPD 2  $\mu$ g  
0.5  $\mu$ g 3  
8 39% 가 349pg/mL 158pg/mL  
5 , Torregrosa  
38) 2  $\mu$ g  
Del-  
mez 34) 2.5mEq/L 가  
CAPD  
,

— 9 —

CAPD 가 ALP 2

가

1, 2 3, 6

41, 41). B-ALP

ALP가 가 ,

Jarava 42

56

ALP(r=

0.85) B-ALP(r=0.79) 가

가 B-

ALP가 가 high turnover

6 5

ALP(r=0.778,  $P<0.05$ ),

B-ALP(r=0.806,  $P<0.05$ )

1 가 osteocalcin 41, 43, 44 B-

ALP (r=

0.391,  $P<0.05$ ), osteocalcin

CAPD ALP 가

Jarava 42

30-40% 가

가 46, DEXA

가 46

가 , 가 가

가 DEXA

alkaline phosphatase( ALP), bone-specific alkaline phosphatase( B-ALP), osteocalcin, (r=-0.503,  $P<0.05$ ), 6 aluminum

가 가

가

Fukagawa 18



# A Prospective Study of the Effect of Calcitriol Treatment according to Administration Route in CAPD Patients

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trial once daily via intraperitoneal route by overnight retention with dialysate, SC(n=11); 1.0 µg of calcitriol three times a week via subcutaneous route, and PO (n=11); 1.0 µg of calcitriol three times a week by ingestion. 11 out of 33 patients(6 in IP, 4 in SC, and 1 in PO) dropped out during the 6-months study period, and 5 among the 6 patients in IP were due to recurrent peritonitis. Biochemical data including calcium, phosphorus, iPTH, alkaline phosphatase, bone-specific alkaline phosphatase, osteocalcin and 1,25(OH)<sub>2</sub>D<sub>3</sub> were measured regularly, and the data of 22 patients who had completed the 6-months study were analyzed. There was a statistically significant decrease in iPTH level(pg/mL) in the three groups after 6-months calcitriol therapy(IP; 812.0 ± 276.7 vs. 354.7 ± 129.4, PO; 571.8 ± 330.7 vs. 159.6 ± 192.3, SC; 786.1 ± 535.0 vs. 551.8 ± 729.9, respectively, P<0.05), but there were no differences in the percentage of decrease in iPTH from baseline values among the three groups. Alkaline phosphatase, bone-specific alkaline phosphatase and osteocalcin also decreased significantly in all three groups(IP; 50.1 ± 14.6, 33.5 ± 11.6, 52.3 ± 10.9% of baseline value; SC; 80.9 ± 14.8, 67.4 ± 20.80, 54.4 ± 11.1% of baseline value; PO; 48.8 ± 24.4, 36.6 ± 23.5, 54.2 ± 11.6% of baseline value, respectively, P<0.05), but they were not different with each other. Among 22 patients who completed the 6-months study, hypercalcemia(Ca 10.5 mg/dL) occurred in 7 patients(31.8%). IP(2/5, 40%) and SC groups(5/7, 71.4%) had significantly higher incidence of hypercalcemia than PO group(0/10, 0%) (P<0.05). IP group(2/5, 40%) also experienced significantly higher incidence of hyperphosphatemia than SC(1/7, 14.3%) and PO groups(1/10, 10%). Peritonitis occurred significantly more in IP than in SC and PO groups(P<0.05). In conclusion, calcitriol treatment resulted in a significant decrement in iPTH levels in CAPD patients and no significant differences were noted in the iPTH-suppressive effect of calcitriol according to the administration route. Because of higher incidence of peritonitis and hypercalcemia in IP and SQ groups, oral ingestion may be the most optimal route for calcitriol treatment in CAPD patients with secondary hyperparathyroidism.

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